

NASA NEPP / HIREV Conference : Example High Density Electronic Packaging Analog-to-Digital Signal Processor Multi-Chip Module



CJ Land June 18, 2014

#### **Harris Corporation Overview**



\$5.1 billion in fiscal 2013 revenue

Connects the world with advanced communications and information systems

Leading provider of innovative solutions in government and commercial markets

Global reach in more than 125 countries

14,000 employees, including 6,000 engineers and scientists



As of July 30, 2013.

#### **Businesses**





# RF Communications

Tactical and land mobile radios, systems and networking applications.

#### **Primary Markets:**

- U.S. Tactical Radios
- International Tactical Radios
- Public Safety

#### Sample Customers:

- U.S. Department of Defense
- NATO Military Forces
- State and Local Governments



# Integrated Network Solutions

IT services, managed services, and clinically integrated solutions.

#### **Primary Markets:**

- IT Services
- Energy
- Healthcare

#### Sample Customers:

- U.S. Government
- Energy Providers
- U.S. Dept. of Veterans Affairs



#### Government Communications Systems

Advanced technology and systems integration.

#### **Primary Markets:**

- Civil
- National Intelligence
- Defense

#### Sample Customers:

- U.S. Department of Transportation
- U.S. Intelligence Community
- U.S. Department of Defense

# Palm Bay Florida Campus Government Communications Systems



Microelectronics
Assembly Facility

Over 3,000 employees Over 1000 engineers Space Programs National Defense Programs

## Harris is a Trusted Supplier - DMEA



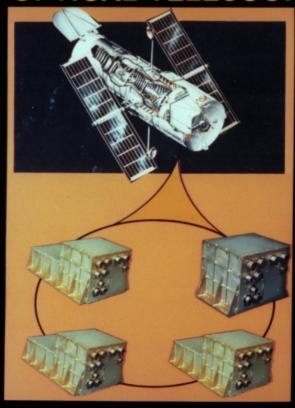
## Certified for Design, Assembly, and Test

- Design
  - ASICs, RF MMICs, Hybrids, MCM's
- Assembly & Test
  - Wafer Probe both Digital and RF to 20GHz
  - Single Chip Packages
  - Hybrids and MCM's

# NASA Space Electronics -- Hubble HARRIS®



### NASA SPACE TELESCOPE **OPTICAL TELESCOPE ASSEMBLY (OTA)**



#### Control and Guidance **Electronic Subsystem**

- Four space-qualified microprocessorbased control and guidance units for OTA (three FGE and one OCE)
- OCE (Optical Control Electronics)—Used in controlling the alignment and surface quality measurement of the main mirror and alignment of the secondary mirror
- FGE (Fine Guidance Electronics)—Used in controlling the precision tracking of the telescope; specifically the search, acquisition, lock, and tracking of the guidance stars

**Program Inception: February 1980** 

# NASA Space Electronics -- Shuttle HARRIS®



#### SPACE SHUTTLE PROGRAMS

PAYLOAD DATA INTERLEAVER

PCM **MASTER UNIT** 

PAYLOAD TIMING BUFFER



- INTERLEAVE DATA FROM:
  - FIVE ATTACHED PAYLOADS
  - TWO CHANNELS OF **DETACHED PAYLOADS**
- INPUT DATA CHARACTERISTIC
  - 10 Hz TO 64 kHz SERIAL TELEMETRY NRZ, L, M, S: BOL, M, S
  - ANY OF FOUR FORMAT TYPES
- PROCESSING OF DATA IS PROGRAMMABLE
- PROVIDE STORAGE OF SELECTED PARAMETERS
- ORBITER QUALIFIED

- ACCEPTS DATA FROM:
  - OPERATIONAL **INSTRUMENTATION BUS** (0/1)
  - PAYLOAD BUS
  - **FIVE GENERAL PURPOSE** COMPUTERS
- FORMATS DATA TO 128 AND 64 kb/s TELEMETRY DOWNLINK
- ORBITER QUALIFIED

- PROVIDES BUFFER AMPLIFICATION FOR ORBITER TIME CODE SIGNALS
- INPUTS IRIG FORMAT GREENWICH MEAN TIME (GMT) MISSION ELAPSED TIME (MET)
- OUTPUTS **EIGHT CHANNELS GMT** FOUR CHANNELS MET
- ORBITER QUALIFIED



HARRIS CORPORATION Government Systems Group - Information Systems

### Space Electronics Space Station



#### Space Station





#### Audio/Video Distribution System

- High Quality Digital Audio for Voice Recognition/Conferencing
- Fiber Optic Video Distribution for Excellent SNR
- High-Definition TV Capability
- User-Friendly Control with Simplicity and Backup
- Multi-Channel, Multi-Access, Full Duplex
   Comm Network

#### THE PAYLOADS



### Space Structures / Antennas







- Largest commercial deployable antenna in orbit
  - 18 meter TerreStar 1
- Fifteen commercial unfurlable antennas on orbit, in build, or under contract
  - TDRS A-F
  - SkyTerra, ICO, TerreStar, ACeS
  - SIRIUS RADIO

MUOS
Two Antennas
5 Meters
14 Meters

Harris Has Over 65000 Square Feet of Production Floor Space Dedicated To Space Antenna Structures

# Space Electronics – High Density Electronics Packaging





GeoEye Satellites
World View Satellites

Photos as seen on Google Earth



Also checkout the Digitalglobe Website for more photos

# Example High Density Packaging

Analog-to-Digital Signal Processor Multi-Chip Module



Very large hermetically sealed MCM – 3.9" x 3.9"

Single row 150 I/O wire bond pads

66 active silicon die

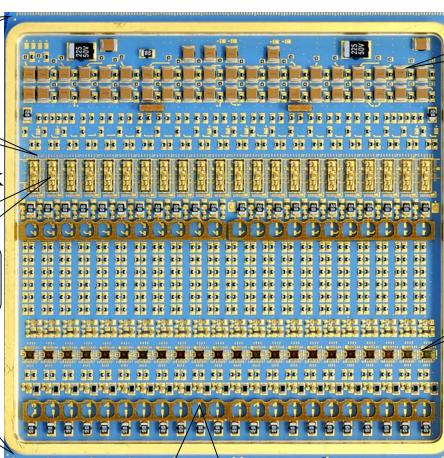
- •Analog-to-Digital ASIC KGD
- •Current source diodes JANCK
- •LVDS Mckt die KGD

Patented Cap-on-Die decoupling capacitors

Proximity to die minimizes capacitor parasitics

16 layer Low Temp Co-fired Ceramic substrate

- •Stringent signal integrity requirements mandate nonrefractory gold metallization
- Matched propagation delays



920 discrete, surface mount components

- •Fully automated pick & place assembly to 0.5 mil accuracy
- •Automatically dispensed structural and electrically conductive adhesive

High reliability reworkable seal ring interface

2600 gold wire bonds

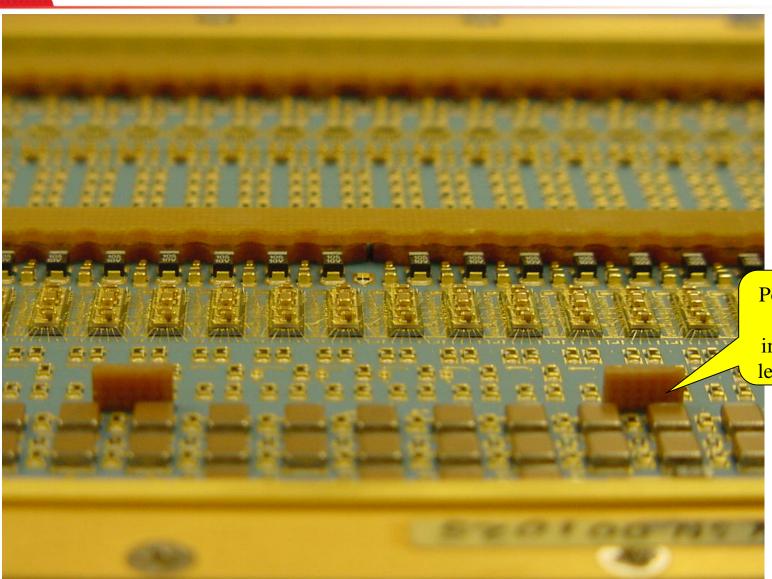
- •High frequency, low temperature thermosonic bonds
- •1.1 mil wire on less than 3.6 mil pitch

0.8 mil gold wire compartmentalized fuses

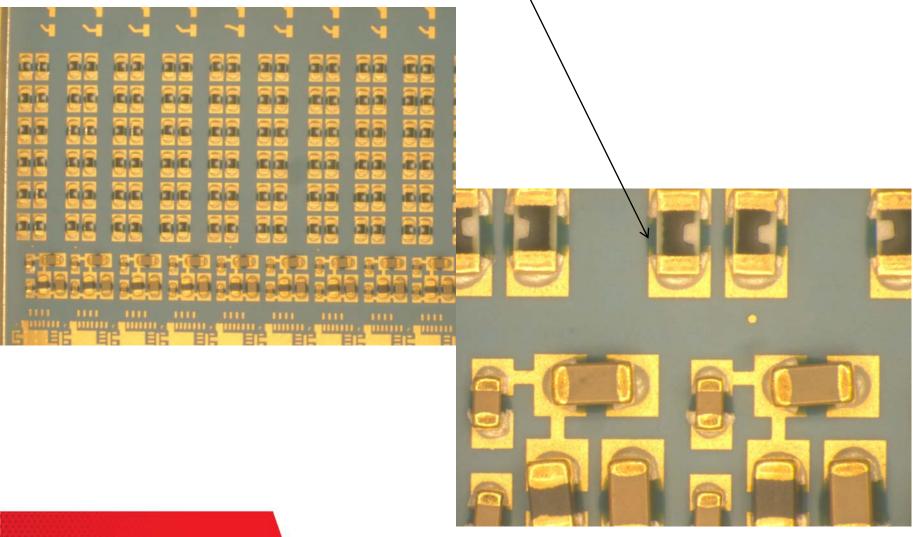
Dual row high density I/O 350 wire bond pads

#### ADSP MCM





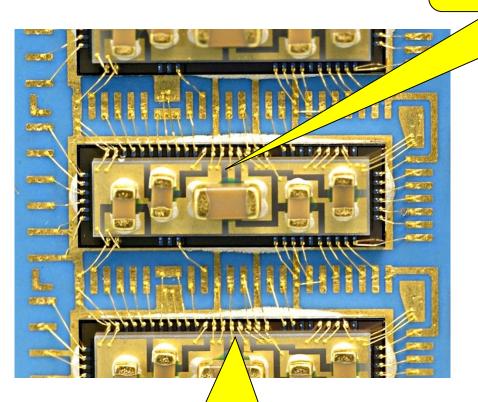
Post to keep the lid from defecting inward during fine leak pressure bomb Examples of Passive Part Attachment Includes structural non-conductive epoxy under the center of the part



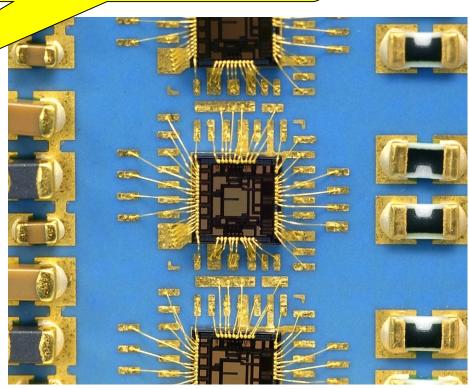
### ASIC and LVDS die



Caps on a Ceramic substrate which is attached to the top of the ASIC die



Kinks in wirebonds are due to the NDBP

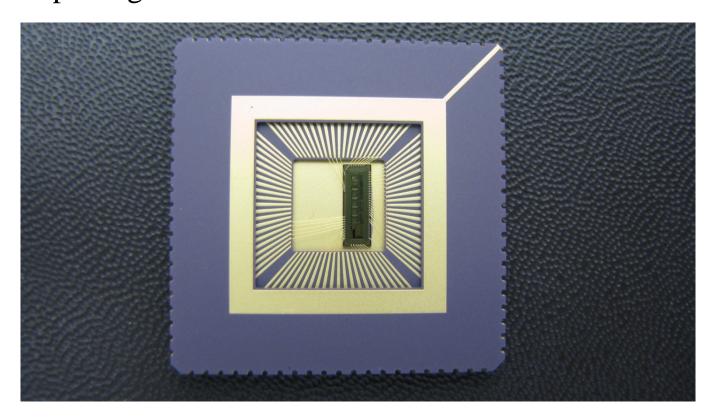


LVDS DIE

# Packaging ADSP ASIC die for Known Good Die Processing

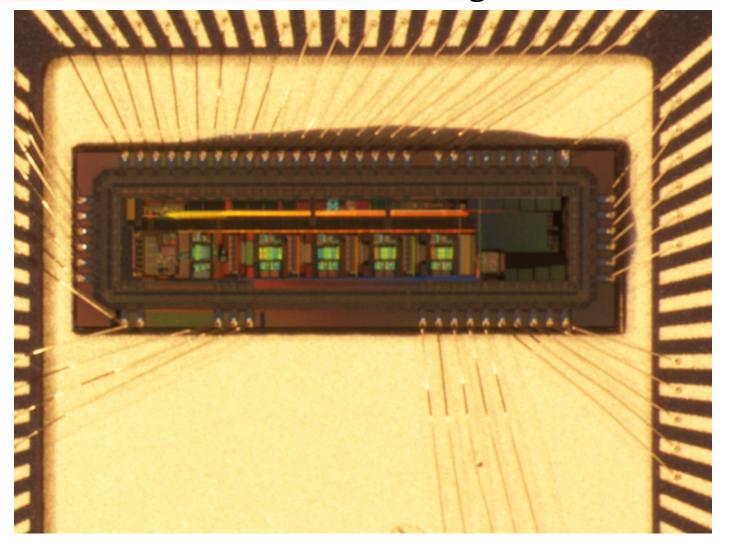


Die is placed into a standard package using proprietary methods which allows the wirebonds to be removed and the die to be taken out of the package after the 240 hr burn-in



# Packaging ADSP ASIC die for Known Good Die Processing





#### ADSP MCM

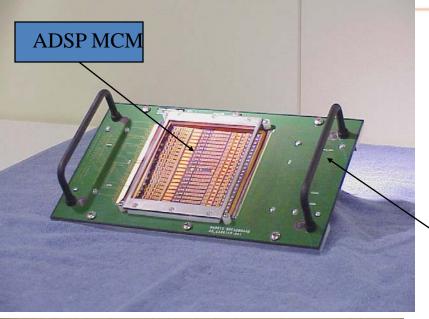
ESD Protection is a Custom Metal Carrier that shorts the bond pads

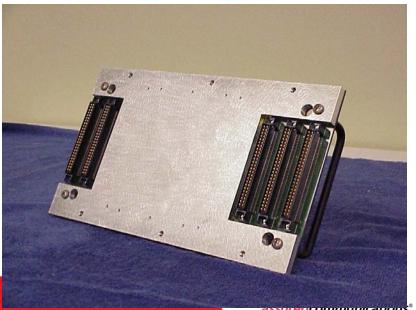




# ADSP MCM Custom Carrier for Electrical Test







A Custom Carrier was designed to contain the ADSP Ceramic Circuit Card for electrical testing. Part is press fit onto carrier and I/O's are wirebonded out to the Carrier Board. Connectors on the bottom plug into the Tester DUT Board

The Carrier Board is a PWB that routes the signals from the wirebonds to the connectors. The backside contains an Aluminum heatsink which the ASDS CCCA has direct contact

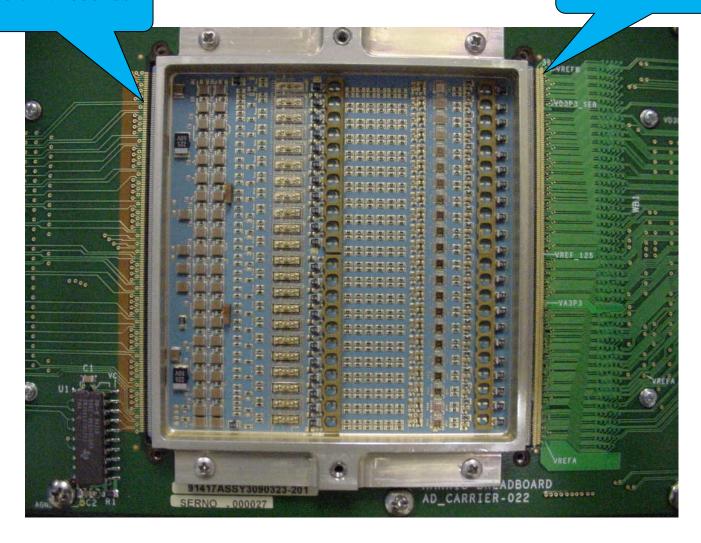
**Back of ADSP Carrier Board** showing connectors that plug into the Tester Device Under Test (DUT) Board

#### ADSP MCM on Test Carrier



150 "Soft" wirebonds

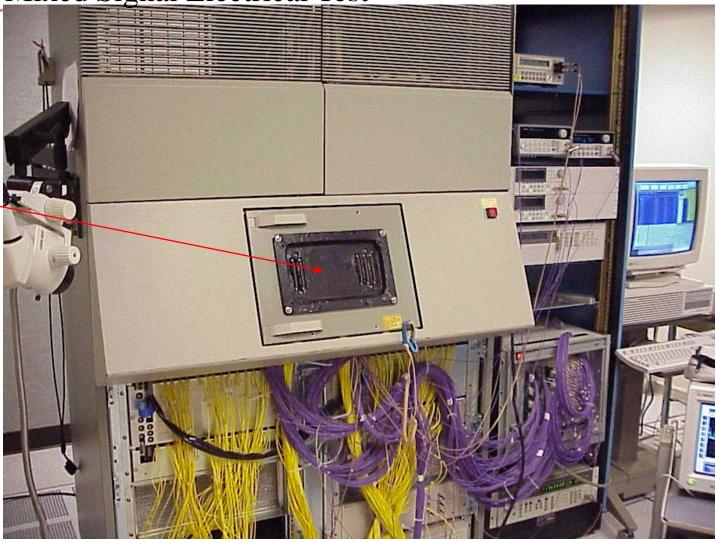
350 "Soft" wirebonds



HP82000 is Custom Configured for the ADSP

MCM Mixed Signal Electrical Test

ADSP in Carrier plugs into the DUT board at the Test Head



**HARRIS**®

# Custom Designed Burn-in Setup can perform Dynamic Burn-in on 16 ADSP MCMs at one time





#### Tailored Processing Prior to Lid Seal



- Assembly
- Non Destructive Bond Pull
- Internal Visual Inspection
- Assemble on to Test Carrier
- Electrical Test over temp
- 48 hour Burn-in
- Electrical Test over Temp
- Remove from Test carrier
- PIND Clean
- Internal Visual Inspection
- Custom Vacuum Bake
- Seam Weld Seal

# Tailored Screening after Lid Seal HARRIS®



Test or Inspection	Conditions
Temperature Cycling	10 cycles, M883, Method 1010, Condition B, -55C to +125C
Hermetic Seal	Fine leak test M883, Method 1014 Gross Leak test M883, Method 1014
Electrical Test	Test at heatsink temperature of +25C
Radiographic Inspection	M883, Method 2012
Random Vibration	M883, Method 2026, 1 minute per axis, system qual levels
Electrical Test over Temp	Test at heatsink temperature of -16C, +25C, +70C
Dynamic Burn-in	160 hours, +100C, M883, Method 1015
Final Electrical Test over Temp	Test at heatsink temperature of -16C, +25C, +70C
Hermetic Seal	Fine leak test M883, Method 1014 Gross Leak test M883, Method 1014
External Visual	M883, Method 2009

#### Qualification Test on 1 device on each Production Lot



Test or Inspection	Conditions
Dynamic Burn-in Life Test	1000 hours, +100C, M883, Method 1015
Electrical Tests at 250hrs, 500 hours	Heatsink temperature of +25C
Electrical over Temp at 1000 hrs	Heatsink temperature of -16C, +25C, and +70C
Temperature Cycles	25 cycles, M883, Method 1010, Condition B, -55C to +125C
Mechanical Shock	M883, Method 2002, Condition A except 100G, 1ms duration, Y1 axis only, 3 shocks
Random Vibration	M883, Method 2026, 3 minute per axis, system qual levels
External Visual	M883, Method 2009
Hermetic Seal	Fine leak test M883, Method 1014 Gross Leak test M883, Method 1014
Electrical Test over Tem p	Heatsink temperature of -16C, +25C, and +70C
RGA Analysis	Moisture < 5000 ppm
Decap Internal Visual	Decap device and inspect per M883, Method 2017
Wirebond Pull Strength	M883, Method 2011, Pull 50 wirebonds randomly selected but including samples from each die type
Element Die Shear	M883, Method 2019 or 2027, Shear 15 die, with at least one die from each die type

#### Harris Technology Interests NEPP / HIREV HARRIS



- 3 D packaging / stacked die techniques
- High density interconnects
- Non-Hermetic packaging for space
- Advanced Hybrid & MCM Manufacturing Technologies
- RF / Microwave Assembly & Test Technologies